Dr. Renyu Hu, Hubble Fellow

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EDUCATION

2013 **Ph.D., Planetary Sciences**, Massachusetts Institute of Technology
"Atmospheric Photochemistry, Surface Features, and Potential Biosignature Gases of Terrestrial Exoplanets", Advisor: Sara Seager

2009 **M.Sc., Astrophysics**, Tsinghua University
"Evolution of MHD Voids, Formation of Magnetars, and Observations of Geo-magnetospheric Reconnections", Advisor: Yu-Qing Lou

2009 **French Engineer's Degree**, École Centrale Paris

2007 **B.Sc., Mathematics and Physics**, Tsinghua University

EMPLOYMENT

2013- **Hubble Postdoctoral Fellow**, Jet Propulsion Laboratory
2013 **Assistant Scientist**, California Institute of Technology

SELECTED AWARDS AND HONORS

2013-16 **NASA Hubble Postdoctoral Fellowship**
2011-13 **NASA Earth and Space Science Fellowship**
2012 **Barrett Prize**, Massachusetts Institute of Technology
2012 **Fellowship**, Sao Paolo Advanced School of Astrobiology
2011 **Fellowship**, NASA Astrobiology Institute Summer School
2009 **Presidential Fellowship**, Massachusetts Institute of Technology
2009 **Best Master Dissertation**, Tsinghua University
2009 **Wu You-Xun Prize**, Tsinghua University
2008 **First-class Academic Distinction Scholarship**, Tsinghua University
2007-08 **AMD Space Science Award**, Tsinghua University
2006-07 **Dean's Summer Student Scholarship**, University College London
2005-07 **Fellowship**, École Centrale Paris
2004 **First-class Academic Distinction Scholarship**, Tsinghua University
2002 **Silver Medal**, The 19th National Physics Olympiad of China

SERVICE

2015 **Panel Reviewer**, Hubble Space Telescope Cycle 23

2014 **Principle Investigator** of science return from direct-imaging exoplanet missions, NASA Exoplanet Exploration Program

2013- **Referee** for ApJ, Astrobiology, Icarus, Earth and Planetary Science Letters, and Astrophysics and Space Science

2012- **Panel Reviewer** for NASA Planetary Atmospheres Program, NASA Exoplanet Research Program, and NASA Earth and Space Science Fellowship

2012-13 **Member**, Working Group 1 (Atmospheric Chemistry, Dynamics and Spectral Retrieval) of the Exoplanet Characterization Observatory (EChO) mission study

INVITED TALKS

2015 University of California, Santa Barbara, KITP Conference: Physics of Exoplanets: From Earth-sized to Mini Neptunes
2014 California Institute of Technology, Kliegel Lectures in Planetary Sciences
2014 University of California, Los Angeles, Planetary Seminar
2013 University of California, Los Angeles, iPLEX Lunch Seminar
2013 California Institute of Technology, Yuk Lunch Seminar
2012 Harvard-Smithsonian Center for Astrophysics, SSP Seminar
2012 Institute for Advanced Study, Seminar

PUBLICATIONS

Refereed Publications

12 first-author papers, h-index = 10, *student advised

[16] **Renyu Hu**, Sara Seager, and Yuk L. Yung (2015), *Helium Atmospheres on Warm Neptune- and Sub-Neptune-Sized Exoplanets and Applications to GJ 436 b*, **ApJ**, in press (arXiv: 1505.02221)

[15] *Peter Gao, **Renyu Hu**, Tyler Robinson, Cheng Li, and Yuk L. Yung (2015), *Stabilization of CO_2 Atmospheres on Exoplanets around M Dwarf Stars*, **ApJ**, in press (arXiv:1501.06876)

[14] **Renyu Hu**, Brice-Oliver Demory, Sara Seager, Nikole Lewis, and Adam P. Showman (2015), *A Semi-Analytical Model of Visible-Wavelength Phase Curves of Exoplanets and Applications to Kepler-7 b and Kepler-10 b*, **ApJ**, 802, 51

[13] **Renyu Hu** and Sara Seager (2014), *Photochemistry in Terrestrial Exoplanet Atmospheres III: Photochemistry and Thermochemistry in Thick Atmospheres on Super Earths*, **ApJ**, 784, 63

[12] Sara Seager, William Bains, and **Renyu Hu** (2013), *Biosignature Gases in H_2-Dominated Exoplanet Atmospheres*, **ApJ**, 777, 95

[11] Sara Seager, Willaim Bains, and **Renyu Hu** (2013), *A Biomass Model for Exoplanet Biosignature Gases*, **ApJ**, 775, 104

[10] **Renyu Hu**, Sara Seager, and William Bains (2013), *Photochemistry in Terrestrial Exoplanet Atmospheres II: H_2S and SO_2 Photochemistry in Anoxic Atmospheres*, **ApJ**, 769, 6

[9] **Renyu Hu**, Sara Seager, and William Bains (2012), *Photochemistry in Terrestrial Exoplanet Atmospheres I: Photochemistry Model and Benchmark Cases*, **ApJ**, 761, 166

[8] **Renyu Hu** and Shuang-Nan Zhang (2012), *Quasars' Optical Polarization and Balmer Edge Feature Revealed by Ultra-violet, and Polarized Visible to Near Infrared Emissions*, **MNRAS**, 426, 2847-2858

[7] **Renyu Hu**, Kerri Cahoy, and Maria T. Zuber (2012), *Mars CO_2 Condensation Above The North and South Poles Revealed by Radio Occultation, Climate Sounding, and Laser Ranging*, **J. Geophys. Res.**, 117, E07002

[6] **Renyu Hu**, Bethany L. Ehlmann, and Sara Seager (2012), *Theoretical Spectra of Terrestrial Exoplanet Surfaces*, **ApJ**, 752, 7-21

[5] **Renyu Hu** (2010), *Transport of the First Rocks of the Solar System by X-winds*, **ApJ**, 725, 1421-1428

[4] Yu-Qing Lou and **Renyu Hu** (2010), *General Polytropic Magnetofluid under Self-Gravity: Voids and Shocks*, **New Astronomy**, 15, 198-214

[3] **Renyu Hu** and Yu-Qing Lou (2009), *Magnetic Massive Stars as Magnetar Progenitors*, **MNRAS**, 396, 878-886

[2] **Renyu Hu** and Yu-Qing Lou (2008), *Self-Similar Champagne Flow of Polytropic HII Regions*, **MNRAS**, 390, 1619-1634

[1] **Renyu Hu**, Yulia V. Bogdanova, Christopher J. Owen, Claire Foullon, Andrew N. Fazakerley, and Henri Rème (2008), *Cluster Observations of the Mid-Altitude Cusp under Strong Northward Interplanetary Magnetic Field*, **J. Geophys. Res.**, 113, A07S05

Submitted Publications

[2] **Renyu Hu**, David Kass, Bethany L. Ehlmann, and Yuk L. Yung (2015), *Tracing the Fate of Carbon and the Atmospheric Evolution of Mars*, **Nature Geoscience**, submitted

[1] Avi Shporer and **Renyu Hu** (2015), *Studying Atmosphere-Dominated Kepler Phase Curves*, **AJ**, submitted (arXiv:1504.00498)

Publications in Preparation

[2] **Renyu Hu** (2015), *Measurement of Methane Mixing Ratio and Cloud Pressure from Exoplanet Reflection Spectrum*, to be submitted

[1] **Renyu Hu**, Anthony Bloom, Peter Gao, Charles E. Miller, and Yuk L. Yung (2015), *Hypotheses for a Near-Surface Reservoir of Methane and Its Release on Mars*, to be submitted

Reports, White Papers, Book Chapters, and Conference Proceedings

[5] Kevin France, … **Renyu Hu**, and 33 coauthors (2015), *Characterizing the Habitable Zones of Exoplanetary Systems with a Large Ultraviolet/Visible/Near-IR Space Observatory*, in response to NASA call for white papers: Large Astrophysics Missions to Be Studied by NASA Prior to the 2020 Decadal Survey (arXiv: 1505.01840)

[4] **Renyu Hu** (2014), *Ammonia, Water Clouds and Methane Abundances of Giant Exoplanets and Opportunities for Super-Earth Exoplanets*, Report of a quick study of science return from direct-imaging exoplanet missions, commissioned by the NASA Exoplanet Exploration Program on behalf of the WFIRST/AFTA Science Definition Team and the Exo-S and Exo-C Science and Technology Definition Teams (arXiv:1412.7582)

[3] **Renyu Hu** (2014), *Photochemistry in Terrestrial Exoplanet Atmospheres*, Invited Chapter in Planetary Exploration and Science: Recent Results and Advances, ed. S. Jin et al., Springer-Verlag

[2] Roy van Boekel, Björn Benneke, Kevin Heng, **Renyu Hu**, and 30 coauthors (2012), *The Exoplanet Characterization Observatory (EChO): performance model EclipseSim and applications*, in Proceedings of SPIE 8442, Space Telescopes and Instrumentation 2012: Optical, Infrared, and Millimeter Wave

[1] **Renyu Hu** and Yu-Qing Lou (2008), *Rebound Shock Breakouts of Exploding Massive Stars: A MHD Void Model*, in AIP Conference Proceedings, 1065, 310-313 (arXiv:0808.3905)

SELECTED CONFERENCE PRESENTATIONS

Renyu Hu (2015), *Measuring Atmospheric Compositions of Giant Exoplanets and Distinguishing Water-World Exoplanets with Direct-Imaging Exoplanet Missions*, Hubble Fellows Symposium, Baltimore, MD

Renyu Hu, Peter Gao, Charles E. Miller, and Yuk L. Yung (2015), *Hypotheses for a Near-Surface Reservoir of Methane and Its Release on Mars*, 46th LPSC, Woodlands, TX, LPI Contribution No. 1832, p.2279

Renyu Hu (2015), *Highly Evolved Exoplanet Atmospheres*, AAS 225th Meeting, Seattle, WA

Renyu Hu, David M. Kass, Bethany L. Ehlmann, and Yuk L. Yung (2014), *Carbon Reservoir History of Mars Constrained by Atmospheric Isotope Signatures*, AGU Fall Meeting, San Francisco, CA

Peter Gao, **Renyu Hu**, Tyler D. Robinson, and Yuk L. Yung (2014), The Role of Hydrogen in Determining the Stability of CO_2 Atmospheres of Terrestrial Exoplanets Around M Dwarfs, DPS 46th Meeting, Tucson, AZ

Renyu Hu (2014), *Helium Atmosphere on Neptune-Sized Exoplanet GJ 436 b Formed by Irradiation Driven Escape*, 40th COSPAR Scientific Assembly, Moscow, Russia

Renyu Hu and Sara Seager (2014), *H_2S and SO_2 Photochemistry in Anoxic Atmospheres of Terrestrial Exoplanets*, 45th LPSC, The Woodlands, TX, LPI Contribution No. 1777, p.1481

Renyu Hu (2014), *Helium Atmosphere on Neptune-Sized Exoplanet GJ 436 b Formed by Irradiation Driven Escape*, Hubble Fellows Symposium, Baltimore, MD

Renyu Hu (2014), *Helium-Dominated Atmosphere on Neptune-Size Planet GJ 436 b*, Exoclimes III Conference, Davos, Switzerland

Renyu Hu and Sara Seager (2013), *Thermochemistry and Photochemistry in Thick Atmospheres on Super Earths and Mini Neptunes*, AGU Fall Meeting, San Francisco, CA

Renyu Hu and Sara Seager (2013), *Photochemistry in Thick Atmospheres on Super Earths*, 44th LPSC, The Woodlands, TX, LPI Contribution No. 1719, p.1428

Renyu Hu and Sara Seager (2013), *Atmospheric Photochemistry and Potential Biosignatures on Terrestrial Exoplanets*, AAS 221st Meeting, Long Beach, CA

Renyu Hu (2012*), Photochemistry of Terrestrial Exoplanet Atmospheres and Applications in Searching for Biosignature Gases*, IAU Symposium 293, Beijing, China

Renyu Hu (2012), *A New Photochemistry Code for Terrestrial Exoplanet Atmospheres*, Modeling Atmospheric Escape Workshop, Charlottsville, VA

Renyu Hu, Kerri Cahoy, and Maria T. Zuber (2011), *Particle Size of CO_2 Condensates in Mars' Atmosphere: a Joint Analysis of Radio Occultation, Climate Sounder and Laser Ranging Experiments*, AGU Fall Meeting, San Francisco, CA

Renyu Hu (2011), *Radial Transport of First Solids of the Solar System by X-Winds*, Workshop on Formation of the First Solids in the Solar System, Kauai, HI, LPI Contribution No. 1639, p.9061

Renyu Hu, Sara Seager, and William Bains (2011), *Can Hydrogen Sulfide Gas Be a Biosignature in a Habitable Exoplanet?*, AAS 218th Meeting, Boston, MA

Renyu Hu (2010), *Transport of First Rocks of The Solar System by X-winds*, ESF Research Conference: Putting our Solar System in Context, Obergurgl, Austria

Renyu Hu and Yu-Qing Lou (2010), *Fossil Fields as The Origin of Ultra-Intense Magnetic Fields on Magnetars*, AAS 215th Meeting, Washington, DC

Renyu Hu and Yu-Qing Lou (2009), *Magnetic massive stars as magnetar progenitors*, The First Panda Symposium, Lijiang, China,

Renyu Hu and Yu-Qing Lou (2008), *Rebound Shock Breakouts of Exploding Massive Stars: A MHD Void Model,* Nanjing Gamma-Ray Burst Conference, Nanjing, China

Renyu Hu, Yulia V. Bogdanova, Christopher J. Owen, Claire Foullon, Andrew N. Fazakerley, and Henri Rème (2008), *Cluster Observations of the Mid-Altitude Cusp under Strong Northward Interplanetary Magnetic Field*, 37th COSPAR Scientific Assembly, Montreal, Canada

SPONSORED RESEARCH PROJECTS

Preparing to Observe Exoplanets with the James Webb Space Telescope and WFIRST-AFTA
Principle Investigator: Charles A. Beichman
Co-Is: Glenn Orton, Wesley A. Traub, Adam Burrows, Thomas Greene, **Renyu Hu**
Sponsor: JPL
Program: Research and Technology Development Program
Funding Period: FY 2015
Total funding: $58,000

Determining the State of Exoplanet Atmospheres
Principle Investigator: Mark Swain
Co-Is: Andrew Friedson, Graca Rocha, Gael Roudier, Kiri Wagstaff, Yuk L. Yung, **Renyu Hu**, Michael Line, Caitlin Griffith, Robert Zellem
Sponsor: JPL
Program: Research and Technology Development Program
Funding Period: FY 2015
Total funding: $40,000

Exoplanet Clouds and Hazes
Principle Investigator: Yuk L. Yung, Mark Swain
Co-Is: Heather Knutson, **Renyu Hu**, Pushkar Kopparla, Peter Gao, Björn Benneke, Dave Diner, Pin Chen, Bruce Hancock, Gautam Vasisht, Robert West, Vijay Natraj, Anthony Davis, Jonathan Jiang
Sponsor: JPL
Program: President's and Director's Fund
Funding Period: FY 2015
Total funding: $400,000

Detecting and Characterizing Exoplanets with the WFIRST Coronagraph: Colors of Planets in Standard and Designer Bandpasses
Principle Investigator: Margaret Turnbull
Co-Is: **Renyu Hu**, Tristan L'Ecuyer
Sponsor: NASA
Program: WFIRST Preparatory Science
Funding Period: April 1, 2015 to March 31, 2018
Total funding: $539,346

Chemical Fingerprints of Alien Worlds – Towards an Evolutionary View of Mars and Terrestrial Exoplanet Atmospheres
Principle Investigator: Wesley A. Traub
Science-PI: **Renyu Hu**
Sponsor: NASA
Program: NASA Hubble Postdoctoral Fellowship
Funding Period: December 16, 2013 to December 15, 2016
Total funding: $316,500

Photochemistry of Super Earth Exoplanet Atmospheres
Principle Investigator: Sara Seager
Science PI: **Renyu Hu**
Sponsor: NASA
Program: NASA Earth and Space Science Fellowship
Funding Period: September 1, 2011 to August 30, 2013
Total funding: $60,000

Pending

Habitability of Mars and Evolution of Its Atmosphere Constrained by Isotopic Measurements
Principle Investigator: Yuk L. Yung
Co-Is: **Renyu Hu**
Sponsor: NASA
Program: Habitable Worlds
Funding Period: August 1, 2015 to July 31, 2018
Total funding: $417,439

MEDIA REPORTS

2013 *Investigating Exoplanet Surfaces*, by Astrobiology Magazine, Phys.org, and SciTech Daily

2012 *Mars Snowflakes Are as Tiny as Red Blood Cells*, by CBS, Nature, Discovery, National Geographic, Reuters, Daily Mail, and Space.com

2011 *How Astronomers May Hunt for Life on Alien Planets*, by Astrobiology Magazine, New Scientist, Space.com, and The Daily Galaxy

TEACHING EXPERIENCE

2015 **Co-Instructor**, California Institute of Technology, Class Ge 194: Isotopic Tracers of Mars Atmosphere-Surface Interactions

2015 **Guest Lecturer**, California Institute of Technology, Class Ge 159: Planetary Evolution and Habitability

2014 **Professional Development Program**, Institute for Scientist and Engineer Educators, University of California, Santa Cruz

2012 **Teaching Certificate Program**, Massachusetts Institute of Technology

2018-10 **Teaching Assistant,** Tsinghua University**,** Class: Quantum Mechanics

REFERENCES

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Smits Family Professor of Planetary Science
California Institute of Technology
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Sara Seager
Class of 1941 Professor of Planetary Science and Physics
Massachusetts Institute of Technology
77 Massachusetts Avenue
Cambridge, MA 02139, USA
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Wesley A. Traub
Chief Scientist of NASA Exoplanet Exploration Program
Senior Research Scientist
Jet Propulsion Laboratory
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